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Structural Assessment of S.P.S Library

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Abstract: ***In general structural assessment is a process to determine the capacity of an existing structure to carry current and future loads and to fulfill its task for a given time period. The paper presents the assessment of the Library under construction from last 13 years, submerged upto first story during September 2014 kashmir floods. Considering the high importance of the building an attempt is made to understand the condition of the building, identify critical areas to repair and suggest corrective measures to ensure safety and serviceability of the existing building and thus save human life. Method of visual Inspection is adopted for the assessment of the building.***

Keywords: Framed Structure, Load bearing Structure, Structural Assessment, Building Inspection, Visual Inspection

1. Introduction

In India, from 1980 onwards the infrastructure industry witnessed stepping up of public investment and growth in infrastructure industry which resulted in construction of new multistory buildings. In many buildings, strength has reduced in due course of time because of structural deficiency, material deterioration, unexpected over loadings or physical damage. If further use of such deteriorated structures is continued it may endanger the lives of occupants and surrounding habitation. There is a demand of appropriate actions and measures for all such building structures to improve its performance and restore the desired functions of structures which may leads to increase its functional life. The periodical structural auditing of existing buildings is thus important to know the health of the structure.

Building inspection is a general surface examination of those parts of a property which are accessible. In other words, the area should be visible and readily available for examination without risk of causing damage to the property of injury to the surveyor service building. The main task for assessment is to ensure that a structure or part of the structure doesn't fail under loading. In order to carry out the inspection, the surveyor requires some basic equipment to be used during the survey. In general four types of inspection are distinguishable: these include visual inspection, concealed object inspection, Dampness inspection, stress and strain survey. In visual inspection, the equipment include digital camera, binoculars, magnifying glass, video recorder etc.

The structural auditing will help to implement maintenance and repair work timely which leads to prolonged life of the building and safety of the occupants. It also helps in delivering a strong building structure with cost effective solutions and appropriate maintenance program.

2. Building Highlights

S.P.S Library is Located in the heart of Srinagar city at Lal Chowk. The building size is 120 ft X 60 ft. The building is 6 stories with basement . The building is under construction from last 13 years.

The building is envisaged to become a hub of intellectual activities in the valley besides being an immense source of Education. It is expected to provide Education and information through the Books and Manuscripts contained in it. At the same time, it shall provide online access to unlimited Databanks of knowledge and information all round the world through a vast internet centre.

The library complex shall have a special section for children, which besides having usual books and literature shall have Audio Visual section where informative programmes can be screened. In order to attract children, means of passive recreation like chess and other mind sharpening board games etc. shall be provided.

A large fire proof manuscript rooms shall house about 8000 rare manuscripts. A large gallery shall be provided to encourage assembly and interaction of the Artist community and other intellectual sections with common people.

Keeping in view the high importance of the building, Structural Assessment has been carried out and necessary actions are suggested to ensure safety of the structure.

3. Methodology

Assessment of structure is done by visual inspection
During visual inspection all component parts of structure are visually inspected like possible occurrence of any wall cracks, length and width of cracks , condition of column , condition of beam ,condition of toilets, condition of flooring tiles, condition of internal and external plaster etc. Visual inspection form is prepared and giving the rating as per the importance of damages. After interpreting the result which gives the structural condition, following points related to structure are detailed visually inspected as:

1) No settlements in the foundations.
2) No Visual cracks in columns but 60% columns out of plum.
3) Most of beams provide apprehension of being deflected .
4) Level difference of atleast 100 mm in slabs, corrected by providing extra flooring thereby increasing the dead

weight of the structure.

5) Concrete disintegration and exposed steel reinforcements observed in some beams. .
6) Leakages & dampness in in third floor bathroom wall resulting into cracks and swelling.
7) Changes carried out affecting structure.
   - Toilet blocks – Bathroom Block Added in third floor and fifth floor after revised drawings
   - Partition Walls Added and some existing walls being dismantled.
8) Status of lift – Lift walls out of plum, Lift opening not provided at first and third floor.
9) Water proofing in basement required to make it functional.
10) Basement Floor completely submerged during September 2014 floods. However, No damage to structural members.
11) Building plans available (Both Old and Revised)
   - Structural Plans available
   - Structural Stability Certificate NOT available
   - Structural Calculations NOT available
12) Last Structural Audit prepared - NO

By visual inspection survey the Health Rating Index of structure is arrived. For this study visual inspection of the existing structure is made and ratings marked as per condition. TABLE 1 shows the visual Inspection ratings given. At the same time the photographs of structure are given in figure1 to figure5

Table 1: Visual inspection ratings

S. No	*Description*	*VB*	*B*	*F*	*G*	*VG*
A	**External building faces & stilts:**					
1	Columns & Beams				8	
	Cracks, Bulging, Corrosion in RCC					
2	Walls & Plaster				8	
	Cracks, Dampness					
3	Porch Slab concrete deterioration, Cracks, Bulging, corrosion in RCC			6		
4	Drainage & Rainwater pipes Leaking, Broken			6		
5	Water supply pipes Corrosion, Low pressure			6		
6	Internal Paint Weathering, Fading, Absence		4			
B	***Staircase, Lobby & Passage:***					
7	Column, beams, Slabs, Parapets, Cracks, Dampness				8	
8	Walls & Plaster, Cracks, Dampness				8	
9	Wooden Frames, Cracks, broken			6		
10	Flooring, Loose, Cracks				8	
11	Paint, Weathering, Fading, Absence			6		
C	***Flats:*** (especially ground floor & top floor)					
12	Columns, Beams, Cracks, Bulging, corrosion in RCC				8	
13	Slabs, Cracks, Bulging, corrosion in RCC				8	
14	Walls & Plaster, Cracks, Hollowness, Dampness, Seepage			6		
15	Toilets, Seepage from above		4			
D	***Other:***					
16	Termites (white ants)					10
17	Rodents (rats)					10
18	Water logging during monsoon	2				
19	Choking of drainage	2				
20	Cracks in compound wall		4			

A R.C.C. Framed structure as visually inspected and giving the ratings as Very Bad- 2, Bad – 4, Fair – 6, Good – 8, Very Good – 10. Inspect building and give ratings in between 2 to 10 as mentioned above.

Figure 1: Plaster crack

Figure 2: Corrosion in RCC due to insufficient cover

Figure 3: Slender columns at building corner

Figure 4: Dampness in wall adjacent to bathroom

Figure 5: Swelling of plaster and tiles in third floor bathroom

4. Design Flaws of the Building

The round columns are provided at the corners in the front elevation of the building for the sole purpose of providing architectural aesthetics. However, the said columns have been casted upto a height of 40 feet without any intermediate lateral support. Large lateral displacement of said columns is observed on giving a slight horizontal push at the top. The effective length of such a column fixed at one end and free at the other becomes 4 times the length of the column. Since the buckling load is inversely proportional to the square of the effective length this implies a slight load will cause considerable deflections in the column. The said columns will also cause knocking effect on the structure even during a low magnitude earthquake and are therefore a severe hazard for the health of the structure ,besides being threat to human life. It is therefore recommended, that the columns should be anchored into the slab at the top into the slab with the help of structural steel . This will reduce the effective length of the columnto one fourth i.e 10 feet and the columns will behave as part of the structure itself. The cavity walls have been provided without any horizontal and vertical bands. This may result in severe cracks particularly at the place of windows even under moderate shaking during earthquake.

One of the main structural drawback is the presence of cut-out slab in fourth floor whose functionality has been changed by the architect. Due to presence of the cutout in the said floor, there is no access to the floor by way of lift. The building has already been casted to 5th floor level and there is no possibility of casting a pure RCC slab in the cut-out due to lack of support on one side and presence of casted beams exceeding the R.L of the slab on the two sides.

On analyzing the beams for the loads, It has been recommended to drill the beams horizontally and provide built-up girders of structural steel for purpose of casting the slab. However, no consideration has been given to the effect of this change on the health of the structure.

Other problem encountered is the lack of accesibilty to the floor from the casted slab portion. In absence of any possibility to cast pure RCC slab for the connection, a structural steel slab connection has been proposed after thorough analysis of the casted beams for the additional loads.

It was also found that the building has varying floor heights. As a result of which column height in different floors is different. The floor with the shortest floor height will be susceptible to short column effect during earthquake. Poor behaviour of short columns is due to the fact that in an earthquake, a tall column and a short column of same cross-section move horizontally by same amount Δ. However, the short column is stiffer as compared to the tall column, and it attracts larger earthquake force. Stiffness of a column means resistance to deformation – the larger is the stiffness, larger is the force required to deform it. Hence, the shortest column in the building will attract large seismic forces and result in maximum damage. On Investigating the drawings, no additional special requirements as per IS:13920-1993 for the short columns have been provided to the columns of the minimum floor height. Application of wrapped FRP jacket or steel jacketing is therefore recommended for short columns.

Besides open ground storey has been provided in the building resulting in sudden drop in stiffness and strength in the ground storey. The soft storey has been provided with RCC walls that do not continue upto the full column height,

and therefore worsen the situation by captive short column effect. It is therefore recommended that the remaining openings along the height of the column be filled with brick masonry to increase the stiffness and avoid short column effect.

5. Result

As per above rapid survey or by visual inspections Health Rating Index (HRI) becomes 6.40, i.e. fair. That means over all structural condition of existing building under inspection is fair. The said Basement + six storey structure is about 13 years old. Our structural opinion says that the whole structure is safe for occupants but changes and improvements as suggested are required with general routine maintenance.

6. Limitation of Present Study

Present study about structural audit is done on the basis of visual inspection method. This is the initial step to carry out the structural audit. By visual inspection only visual damages or defects in components of building are observed. This is the initial stage of structural audit of buildings. To get more specific reasons for damages and defects, Non Destructive Tests (NDT) is necessary. By these test results the strength of different components of existing old buildings can be worked out. It is very useful to decide repair and maintenance method.

7. Conclusion

- The HRI of the the Library is fair.
- From structural audit overall inspection of structure carried out and it beneficial to decide remedial measures to any type of structural defects and damages.
- Based on the overall inspection, Remedial measures are suggested to structural defects and damages to improve overall health of the structure.
- The building being older than 13 years and considering the importance of the building, it is advisable to carry out compulsory structural auditing every 3 years regularly as many harmful modifications self inflicted damages get also checked during auditing.

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